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It may be observed that if the centres of force are not Newtonian, *i.e.* do not attract according to the law of the inverse square of the distance, the method which has been followed will lead to an analogous but slightly different result from that enunciated above.

Comparison of Photographic and Visual Magnitudes of the New Star in Perseus. By W. H. Robinson.

(*Communicated by Arthur A. Rambaut, M.A., Sc.D., F.R.S., Radcliffe Observer.*)

Observations of the brightness, spectrum, colour, position, motion, and nebulous envelope of *Nova Persei* have from time to time been published, but very few photographic magnitudes of the star have as yet appeared. The results given in the present paper may therefore be of some interest and value.

Visual observations of the new star were commenced at the Radcliffe Observatory on February 25, when the writer—on his own initiative—commenced a series of thirty-three photographs of the region of the *Nova.*

The instrument employed was a half-plate camera with 1-inch doublet of superior quality covering a field of about 30° diameter. The camera was mounted on a small equatorial stand, and was readily adjustable to any desired position. The images of the stars were recorded as trails, no clock-work being introduced. Ilford Special Rapid plates were employed, and the development was effected with pyro-gallic.

The photographic magnitudes given in the present paper have been obtained in the following manner :—

A list of comparison stars, fourteen in number, was first prepared (Table I.), care being taken to select, where possible, only such stars as were in the immediate vicinity of the *Nova*, and evenly distributed around it ; but in order to include the five brightest stars in this list it was found necessary to take in an area greater than that for the nine fainter ones, which are all contained within a field 3° by 5°.

The group of moderately bright stars near *α Persei* is clearly shown on most of the plates, but its zenith-distance is much less than that of the new star, and is in consequence unsuitable for determining magnitudes by the differential method. The inclusion of the stars comprising this group would have necessitated the application of absorption-corrections, more or less doubtful in amount ; and since the density of the trails of stars of any given magnitude increases with their declinations, further slight corrections depending on this cause would have been necessary. For these reasons this group has not been used and has not been included in the list.

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The stars selected for comparison of magnitudes with the *Nova* were the following :—

TABLE I.

List of Comparison Stars.

Star's Name.	Tabular Mag. (Harvard Scale.)	Star's Name.	Tabular Mag. (Harvard Scale.)
Capella	0·18	*l* Persei	4·84
α Persei	1·94	30 Persei	5·37
β Persei	2·31	36 Persei	5·40
ε Persei	3·04	Arg. Z. + 45°, 811	5·64
δ Persei	3·18	Arg. Z. + 43°, 818	5·97
ν Persei	3·90	Arg. Z. + 44°, 734	6·23
κ Persei	4·01	Arg. Z. + 42°, 795	6·30

The trails of the comparison stars and *Nova* were examined in transmitted light with a focussing glass, and their densities estimated by steps of sequences on an arbitrary scale of approximately ten or fifteen steps to a magnitude, the brightest star on the plate, *Capella*, being taken as very nearly zero, and *ν Persei* as 50.

The portions of the trails selected for comparison were, with very few exceptions, those corresponding to the same G.M.T.'s of exposures. The reliability of these estimations is strengthened by the fact that not until the final stage of conversion from densities into magnitude had been completed was any reference made to magnitudes of the *Nova* from other sources.

When a series of estimations had been obtained in this way the results were laid aside, and a second examination of the plates, on the same lines, was independently carried out. A duplicate series was thus secured, the results of which exhibited such close agreement with those of the first that further measurements were considered unnecessary.

The two series of results are shown in the following table, each result being the mean of several estimations.

TABLE II.

Mean Photographic Scale Estimations of Brightness of Comparison Stars.

Star's Name.	1st Series.	2nd Series.	Adopted Mean.
Capella	4	3	3·5
β Persei	21	21	21
α Persei	23	21	22
ε Persei	29	28	28·5
δ Persei	32	32	32
ν Persei	50	50	50
κ Persei	60	59	59·5
l Persei	63	63	63

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Star's Name.	1st Series.	2nd Series.	Adopted Mean.
30 Persei	66	66	66
Arg. Z. + 45°, 811	68	67·5	68
36 Persei	71	71	71
Arg. Z. + 43°, 818	80	81	80·5
Arg. Z. + 44°, 734	81	81·5	81
Arg. Z. + 42°, 795	82	82·5	82

The magnitude-equivalents for the arbitrary scale were next determined.

On square-ruled paper the scaled and tabular values were plotted, the former, from Table II., as ordinates, and the latter, from Table I., as abscissæ; the points thus obtained and a smooth curve drawn through them are exhibited in fig. 1.

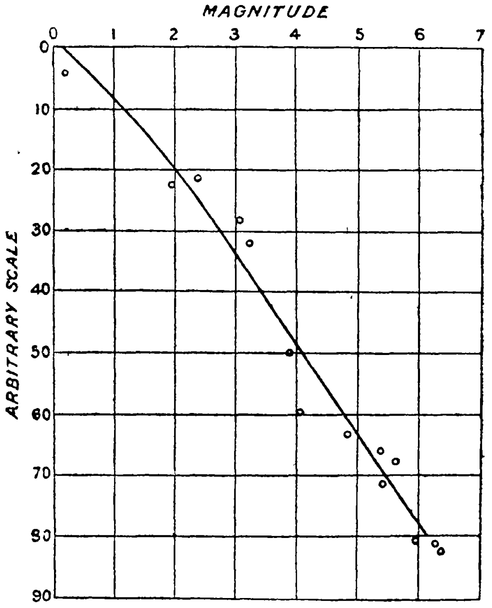

Fig. 1.—The position near 60 scale reading is that of κ Persei, an orange-coloured star.

From this curve the following equivalents were deduced :—

Table III.

Conversion of Scale into Magnitude.

Scale.	Magnitude Equivalent.	Scale.	Magnitude Equivalent.
0	0·15	30	2·75
5	0·65	35	3·10
10	1·15	40	3·45
15	1·60	45	3·75
20	2·00	50	4·05
25	2·40	55	4·40

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Scale.	Magnitude Equivalent.	Scale.	Magnitude Equivalent.
60	4·75	75	5·80
65	5·10	80	6·15
70	5·45		

The equivalents given in Table III. were then adopted in forming the photographic magnitudes of the *Nova* shown in columns 5 and 6 of Table IV. A satisfactory agreement of the two sets of magnitudes is shown to exist. The greatest differences occur at the beginning of the series when the number of stars available for comparison was very limited and scattered over a comparatively large field, as before stated.

The second column of Table IV. contains the G.M.T. of exposure. The last column gives the visual magnitudes from Radcliffe observations, made at nearly the same G.M.T.'s, published in the *Monthly Notices* of the R.A.S., 1901 March, April, and May.

The general agreement of the last two columns—photographic and visual magnitudes of the *Nova*—is very striking. On two dates only, April 15 and 20, the differences of magnitude exceed 0·25, and in both these cases the photographic magnitude is *brighter* than the visual.

The eight bracketed results in column 7, independently derived from different photographs, are also remarkably accordant.

Table IV.

Comparison of Photographic and Visual Magnitudes of Nova Persei.

No.	G.M.T.		Photographic Scaled Densities.		Photographic Magnitudes.			Visual Magnitudes (Means).
			1st Series.	2nd Series.	1st Series.	2nd Series.	Means.	
1	1901. Feb. 25	8^h	9	8·5	1·05	1·00	1·02	0·90
2	26	10	13	8	1·42	0·95	1·18	1·17
3	28	7	16	17	1·68	1·76	1·72	1·58
4		9	18	16	1·84	1·68	1·76	
5	March 1	8	23	21	2·24	2·08	2·16	1·99
6	5	7	27	24	2·54	2·32	2·43	2·42
7	9	9	46	44·5	3·83	3·72	3·77	3·61
8		9½	45	45	3·75	3·75	3·75	
9	11	11	45·5	46	3·78	3·81	3·80	3·93
10	12	11	44	44·5	3·69	3·72	3·71	3·87
11	13	8	44	47	3·69	3·87	3·78	4·03
12	16	8	46	46	3·81	3·81	3·81	3·83
13		9	43·5	46·5	3·66	3·84	3·75	
14	20	9	44	45	3·69	3·75	3·72	3·74
15		10½	45	45	3·75	3·75	3·75	
16	21	9½	48	47·5	3·93	3·90	3·92	3·91
17		11	51	47·5	4·12	3·90	4·01	

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No.	G.M.T.			Photographic Scaled Densities.		Photographic Magnitudes.			Visual Magnitudes (Means).
	1901.			1st Series.	2nd Series.	1st Series.	2nd Series.	Means.	
18	March	22	8h	63·5	65	5·00	5·10	5·05	5·20
19		23	9	45	42·5	3·75	3·60	3·68	3·92
20		25	8	65	65·5	5·10	5·13	5·12	5·15
21			11	65	66	5·10	5·17	5·13	
22		26	9	49	48·5	3·99	3·96	3·98	4·12
23		27	8	45	47	3·75	3·87	3·81	3·98
24			11	47	46	3·87	3·81	3·84	
25		28	9	61·5	59	4·85	4·68	4·76	4·61
26		30	9½	49·5	48	4·02	3·93	3·98	4·14
27			10½	50	49	4·05	3·99	4·02	
28	April	10	9	68	69	5·31	5·38	5·34	5·33
29		13	9	55·5	53	4·43	4·26	4·35	4·49
30		15	11	68	68	5·31	5·31	5·31	5·82
31		17	9	59	58	4·68	4·61	4·64	4·62
32		19	9½	67	70	5·24	5·45	5·34	5·13
33		20	9	71	71·5	5·52	5·56	5·54	5·83

No. 2. Not in good focus. Nos. 9 and 10. Very faint; very misty sky. No. 11. Images not good, too near edge of plate. No. 19. Varying images; cloudy. No. 30. Small altitude; trails good. No. 32. Very faint.

The last two columns of Table IV. are represented graphically in fig. 2. The ordinates of the two curves are, for the sake of clearness, separated by a constant quantity (one magnitude); unless this had been done the curves would have been superposed in places and would have presented a confused appearance.

A glance at this diagram will show that every change of

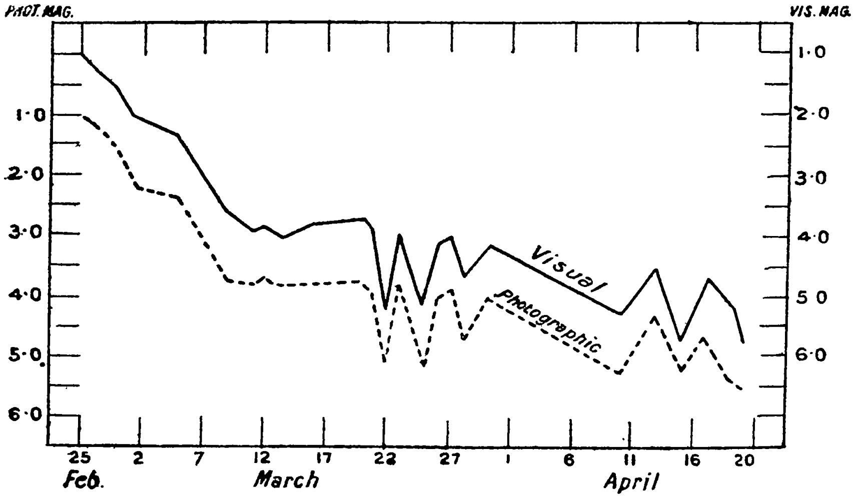

Fig. 2.—Comparison of Photographic with visual magnitude of Nova Persei.

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brightness as determined visually has its counterpart in the photographic curve, so that the two corroborate each other in every particular.

The parallelism or identity of the curves in this figure appear the more remarkable when it is remembered that the *spectrum* of the star also exhibited considerable fluctuations in unison with those of magnitude, as proved by the extensive series of spectroscopic observations at Kensington and Stonyhurst. The director of the latter observatory, in a paper recently communicated to the *Astronomische Nachrichten* (No. 3756), says:—

"A comparison of all the photographic plates of the star's spectrum obtained at Stonyhurst with the light-changes observed at the Radcliffe Observatory, Oxford, has shown that the changes of the spectrum follow, not the phases of the light-curve, but the absolute magnitudes of the star's brightness. The new spectrum, which at first appeared to be associated with the minimum phase, was found on all the dates on which the star's magnitude was less than 4·57 both in March and April; and the old spectrum always returned when the magnitude was greater than 4·57."

Sir Norman Lockyer (*Proc. R.S.*, vol. lxviii. 231) writes:—

"Accompanying the great diminution in the light of the *Nova* observed on the evening of the 25th [March], the spectrum was found to have undergone a great change: the continuous spectrum had practically disappeared, and a line near D (probably helium, D_3) became more distinct. The other lines were hardly visible." The same astronomer further remarks:—"It has been noted that the lines 447, 501, and D_3 appear to vary with the magnitude of the star, becoming relatively more prominent towards a minimum" (*Proc. R.S.*, vol. lxviii. 403).

Closely related to the question of changes in the spectrum of the *Nova* is that of variation in the *visual colour*. On this subject Dr. Rambaut, in the *Monthly Notices* for 1901 April, wrote: "A comparison of the notes on the colour of the star with the variation in its brightness seems to indicate some relation between these two phenomena, and suggests that a diminution of light is accompanied by an increase in the redness of the star." In the next number of the *Notices* the Radcliffe Observer remarks:—"The suggestion made in the last paper that the change in tint was closely related to fluctuations in brightness has been fully confirmed." More recently Herr Osthoff has published (*Astronomische Nachrichten*, 3751) a diagram exhibiting the marked relationship which existed between the variations of visual magnitude and those of colour.

It would therefore appear that, notwithstanding the striking changes in the quality of the star's light, as shown by the spectroscope, and the changes observed in its colour, the variation in the general intensity of the light proceeded *pari passu*, whether measured visually or photographically.

The difficulty of obtaining magnitudes of the *Nova* from long-exposure photographs for comparison with visual magnitudes is

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brought out clearly by Mr. H. Ellis in his paper entitled "Notes on some Photographs of *Nova Persei*," published in the *Journal of the British Astronomical Association*, vol. xi. No. 6. Mr. Ellis took his pictures of the *Nova* with a 5-inch portrait lens and with a large mirror on several nights from February 25 to March 10, using Ilford Special Rapid plates (carefully backed). He remarks:—"In examining these plates, it is very noticeable that the image of the *Nova* is large; in fact, it does not seem to have diminished in size, although by March 10 its light had much diminished and become very orange, with flashes of crimson, when viewed in the guiding telescope."

It will be seen in Table IV. of the present paper that a fall of nearly three magnitudes occurred between February 25 and about March 10.

Mr. Ellis proceeds: "In all the plates the image is larger than *α Persei*. . . . The reason of this, I think, must be the large gaseous envelope which the spectroscope shows to be present."

The nebulous envelope, if it existed at the time of Mr. Ellis' photographs, was not sufficiently actinic to be photographed with short exposures or by the trail method. The exposures by the trail method (within small limits of declination) possess the exceptional merit of being not only *short* but *always equal*; and these conditions seem to be essential when photographs of an object such as the *Nova* are required for comparison from night to night.

The chemically active quality of the light of the new star is emphasised by contrast with that of other reddish stars. This is shown on plate No. 7 (March 9, 9^h), which, after being exposed on the Nova, was exposed on the first magnitude orange-red star *α Orionis*, when it was at the same altitude as the new star and probably not so red.* From a discussion of the data afforded by this plate the resulting magnitudes were found to be:

	Photographic.	Visual.
α Orionis	3·20	0·91†
Nova Persei	3·77	3·61

It may be mentioned, in conclusion, that the trails were examined for any evidence of rapid changes of light similar to those seen on February 24 by Herr Archenhold,‡ but no sudden changes were found, except such as were attributable to atmospheric causes.

Radcliffe Observatory, Oxford: 1902 *January* 6.

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[*] *Nova röthlich.* Harkányi (*A.N.* 3706). *Nova tief roth.* Köhl (*A.N.* 3709).

[†] Harvard Photometry.

[‡] "Die plötzliche Lichtabnahme der Nova und ihr völliges Verschwinden waren so etwas Aussergewöhnliches, dass ich zunächst an eine atmosphärische Ursache dachte. Nur der Umstand, dass ich die umliegenden schwachen Sterne wie ν, ψ, δ, und σ Persei während dieser Zeit deutlich wahrnahm, liessen auch die Möglichkeit zu, dass es eine wirkliche Lichtabnahme der Nova sei" (*Ast. Nach.* No. 3694).

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Period and Light Curve of 6685 *Y Lyræ.*[*]

By A. Stanley Williams.

The earlier observations of this star seemed to suggest a moderately long period, and one of about eighty-six days was proposed by Dr. Hartwig in 1900,[†] whilst at about the same time I thought it might be forty-two days, or about half the above value. Observations of the star were commenced here in 1901 May with the object of solving this question, and after these had proceeded for some time it became evident that the real period was actually a very short one. The question was finally decided on August 18, on which date the star was observed shortly before the rise from minimum had commenced, and followed up to and past maximum; whilst further observations soon showed that the true period was very nearly half a day. About the same time Dr. Hartwig was making a series of observations of the star at the Bamberg Observatory. His earlier observations are referred to in *A.N.* 3744.[‡] These were inconclusive, but further observations in the latter part of August made him suspect that the variable had a short period. Dr. Hartwig was unable to continue his observations at this time, but later on he was able to fully confirm the rapid variability of the star, and his observations are in good agreement with the others.

The results contained in the present paper are based upon a total of 239 visual observations. Fourteen of these were made by Dr. Hartwig with the 10-inch Bamberg refractor. The others were made at Hove with a 6½-inch reflector, a power of 110 being usually employed, but occasionally one of 225 was made use of on moonlight or hazy nights. These observations are all included in the period comprised between 1901 May 13 and November 3. The following is a short description of the method of observation, the reduction of the observations, and the determination of the magnitudes of the comparison stars.

In order to eliminate the effects of what has been called "position error," three principal methods may be employed, namely (1) we may observe the group of stars under all possible angles of position with respect to a line through the eyes; (2) we may observe the group with the eyes always in the same position; and (3) in comparing each comparison star separately

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[*] The star is designated *X Lyræ* in the "Companion to the Observatory." Its place for 1900 is α 18^h 34^m 12^s, $\delta + 43° 51'\cdot 8$.

[†] *Vierteljahrsschrift d. Astr. Gesell.*, Jahrg. 35, Heft 4, p. 276.

[‡] In this note doubt is thrown upon the identity of the variable with a star of about 12^m, but they are actually one and the same object. It will appear from the present investigation that the light curve is rather a peculiar one, and that the star is only at all bright for about three hours out of twelve, whilst the period is so nearly half a day that it is possible to observe the star night after night for a long interval of time without any decided change of brightness becoming apparent.